A Review on Routing Design Issues and Protocols in Data-Centric Network

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Summary
In recent years, excessive use of WSNs applied in different areas such as security surveillance, disaster management, health monitoring and inhabitant monitoring. Some functions, like transmission and processing of sensor nodes, require energy and need to be driven to maintain the sensor nodes functioning. It's going to be hard to recharge the node of the sensor in the remote region. The nodes of the sensor are installed in an unsupervised environment. It is problematic or impossible to recharge or swap batteries in such a circumstance. Maintaining a long lifetime is a critical concern for WSNs, as "Data-Centric Routing" Protocols carried out "data aggregation" to accomplish energy-efficient propagation. This article will shed light on the main design issues of the routing protocols and data-centric protocols (Flooding and Gossiping, SPIN, DD, EAR, COUGAR, ACQUIRE and Rumor Routing) would be discussed and compared with each other.

Keywords:
Data-centric, Routing, design issues, Protocols, WSNs.

1. Introduction

The Wireless Sensor Network (WSN) is generally viewed as one of the best beneficial achievements in the twenty-first century. Wireless sensor networks eventually built from the concept that compact wireless sensors can be employed to gather data from the real world in a wide variety of circumstances, varying from wild fire surveillance and animal surveillance to agricultural control and industrial monitoring. Every sensor conveys data wirelessly to the base station. Sensors enable each other transmits data to the base station [1]. WSNs comprise of low sensor nodes designed to fit with sensor board, processing and wireless communication potential. The role of energy-efficient monitoring of the surrounding area for temperature, humidity levels was assigned to the sensor nodes at the commencement of the WSNs. A sensor hub by and large comprises of four principle components: a sensor unit, a handling unit, a correspondence unit, and a force unit. The sensor unit typically comprises of at least one sensors and simple to-computerized converters (ADCs). Sink then interacts with the outer environment and offers sensed data. All sensor nodes can interact with a base station that is capable of communicating with other devices through additional means. Networks include LAN, WLAN, WPAN and the Internet [2]. The challenge with the use of sensor nodes lies primarily in the fact that these sensors suffer energy and bandwidth issues. Study has also centered emphasis on system-level awareness of energy. The aim is to allow data to be relayed from the nodes of the sensor to the sink in a quite effective and efficient manner. This would increase the lifetime of the network. This is accomplished by using radio networking systems, system partitioning, dc voltage scaling, and various other node battery devices as sensor nodes that can logically be placed in harsh environments [3]. The key current condition is that the node of the sensor will have a comparatively small battery operated so that it may be very hard and often impossible to repair or recharge the sensor nodes batteries. There are various methods for the conservation of energy consumption for WSNs, including radio optimization process, data reducing etc. WSNs are viewed with a range of sensor node installation, computation, memory constraints with less reliable sensor nodes and independent control. The exceptional functionalities and inadequacies thus face a range of additional difficulties for the implementation and growth of WSNs [4].

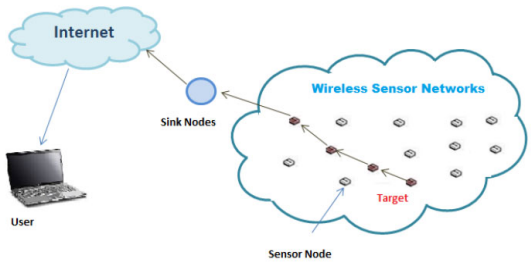

Fig 1: Wireless Sensor Networks [5]

In WSN, it is not possible to delegate a global identity to a node due to high intensity and bandwidth. Such methods as a data aggregation are considered to prevent power consumption the leading cause of routing in these systems is Data-Centric rather than Address-based [6] [1]. The Base-Station sends its queries to Data-centric protocols. Evaluate the surroundings in their protocols and listen to the inputs to be gathered from the

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sensors in the field. It is to suggest, the characteristics of the sensor are even more important than the addresses of the sensor. These features include location, metrics that can be measured, and some basic data-centric protocols. The content of this article is set out as follows: Section 2 discusses design issues of routing protocols. In Section 3 we discuss various Data-Centric Routing protocols. Section 4 compares these Data-Centric Routing protocols. Section 5 describes the conclusion of the review.

2. DESIGN ISSUES OF ROUTING PROTOCOLS

2.1 Fault Tolerance

There are many causes that may contribute to node failure in WSNs, like physical injury, loss of power or system failure. The operation of the whole network must not be stopped by a malfunction of one or a few. This is assured by the system of fault tolerance [7, 8]. The routing protocols developed for WSNs must then use fault tolerance methods so that WSN processes are not influenced by faults. Multipath routing, which improves the system availability, device stability and system consistency is the most widely used fault tolerance approach.

2.2 Node Deployment

The deployment of the node may be deterministic. This means that the sensors are manually positioned and, as a result, the info is guided through pre-determined paths. In the other hand, the implementation of the network might be self-organizing. This implies that the nodes are quite scattered at random since they are in an ad hoc fashion [9].

2.3 Energy Considerations

The creation and usage of courses while creating foundation deals with the energy issue. The radio sends data, which is corresponding to the distance and furthermore to the obstructions that happen in the course. Hence, multi-jump steering devours substantially less immediate interchanges. On the off chance that the objectives are like the sink, close correspondence is simpler and snappier. However, since the hubs are dispersed here, multi-jump is the best option. [10].

2.4 Data Delivery Models

The data delivery model might be continuous, event, query and hybrid driven relaying on the network sensor. Almost every sensor conveys data constantly to the "continuous" delivery model. In event and query driven models, the data transmitted is initiated when an activity occurs or a request is created by the sink. Some applications use a hybrid model that incorporates continuous, event and query driven data delivery [11].

2.5 Scalability

The number of nodes deployed in the area of the node can be hundreds or thousands or even more. Each routing protocol should be sufficient for this large number of nodes. In fact, wireless networks protocols for sensors must be appropriately scalable to address environmental events. In the presence of an event, several sensors stop working, with data from the few remaining sensors providing poor output [11].

2.6 Network Dynamics

Many communication protocols assume that the nodes are static. Movement of either the Base Station or the sensor nodes is also necessary in a variety of applications. Effective ways to communicate from or to obtain the information network is more challenging, as the durability of the path becomes a major obstacle in order to contribute to energy resources, throughput, etc. Dependent on the application, the sensed mechanism can be either static or dynamic. It is complex in target-monitoring systems, but static in possibly early fire control forest surveillance. Monitoring static events provides an incentive for the network to function in a reactive manner, simply by stimulating traffic while monitoring [11]. Dynamic activities in certain networks require regular monitoring and thus generate ample traffic to be routed to the Base Station.

2.7 Data Aggregation/Fusion

As mentioned above, nodes also generate information that is very redundant. For this function, duplicate packets sent from separate nodes may be aggregated to reduce the number of communications. This is achieved by integrating data with the suppression function (which means duplicates elimination). Other operations, like min, max, and average, can also be utilized. Data simulation uses less resources than transmission, which is why data aggregation is the ultimate method. The data aggregation method saves valuable resources effectively and optimize traffic [12]. The conglomeration activities are regularly dispensed to hubs that are effective and prepared in a portion of the channels. Information conglomeration is frequently conceivable with the utilization of such techniques, for example, the sign handling strategy. This is alluded to as an information combination. Along these lines, the hub can deliver a sign which is substantially more solid by dispensing with impedance and furthermore by utilizing a pillar shaping strategy to incorporate the signs together [13, 14].

2.8 Node Capabilities

Various functions may be correlated with sensor nodes in a sensor network. In previous work, each sensor nodes are called homogeneous, getting sufficient processing, communication and power capacity. However, on the basis of a system, nodes can be allocated for a particular reason, such as relaying, sensing and aggregation, because the use of the three procedures at a certain time on a node may efficiently occupy the resources of that node. For example, certain devices can require a complicated combination of sensors for measuring the temperature, pressure and humidity of the ambient environment, detecting the presence of acoustic signatures, and capturing the image or video recording of object tracking [11].

2.9 QoS

Service quality includes the level of service required by the process, process time, reliable output, energy management and geographic location, collaborative-processing. All such modules are greatly impaired when choosing a network routing protocol. Under a certain cases (e.g. military applications), the data would be circulated inside a predefined duration from the moment it is observed [15].

3. DATA-CENTRIC PROTOCOLS

Considering the number of nodes deployed in many WSNs, that's not possible to assign global identifiers or address nodes to each node. All these lacks of collective identification, along with the arbitrary placement of nodes, makes it increasingly challenging to pick a certain community of sensor network. In Data-centric protocols, whenever the source sensors send their data to the sink, intermediate sensors can operate some type of data aggregation from different source sensors and send aggregated data to the sink. This approach would lead to resource consumption due to less data transfer from the source to the sink. There are some data-centric routing protocols we're aiming below, such as Flooding and Gossiping, Sensor Protocols for Negotiation Information (**SPIN**), Directed Diffusion (**DD**), Energy-Aware Routing (**EAR**), Rumor Routing (**RR**), COUGAR, ACQUIRE.

3.1 Flooding and Gossiping

These two significant mechanisms are for information moving inside the remote sensor network. These protocols undoubtedly cannot provide an appropriate anticipatory calculation of steering in the remote sensor network. In the Flooding Method, any sensor that gathers information will transfer it further from the sender to its neighbors and this loop will continue before the information hits the target as well as the expected hops to pass the information. Even so, in Gossiping, which is Flooding's moderate representation, a sensor that receives any information can transmit it to one of its neighbors that is arbitrarily chosen. It will continue until the information has completed its target. Mentioned protocols are only applied, are just applied however they have heaps of issues. One challenge is Implosion Flooding, in which information arrives at the sensor in at least two directions. This is illustrated in Figure 2 (A). Another problem concerns the fact that at least two sensors that are close to being viewed as a zone transmit one type of information to one sensor. Figure 2 (B) is the third issue of shut convention because of fuel sources and bandwidth in the organization. In Gossiping, there isn't a collapse issue any longer, since only one neighbor will be chosen for shipping off. However, fundamental issue of Gossiping is its long postponement [16].

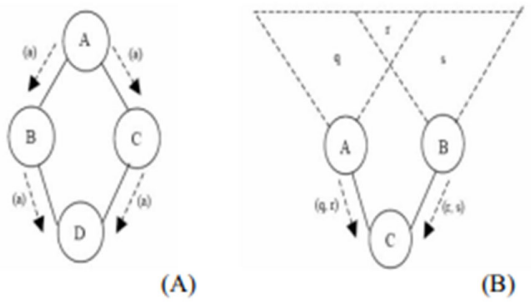

Fig 3: (A) The implosion problem. (B) The overlap problem. [3]

3.2 SPIN

Sensor Protocols for Information via Negotiation (SPIN) works on improving the flooding procedures and on reducing the issues they can cause, for instance, to implode and cover. Energy usage may be a metric in the SPIN protocols which use transmitting more, accepting information about the entity. It's a conscious asset and a flexible asset. As a result, they will make effective decisions on the accurate usage of their individual resources. The SPIN protocol is focused on different methods, such as adaptation and allocation of resources. Turn convention every sensor above all else arrange the information with other sensor hub before information dispersal. So dodge repetitive data in the organization. In SPIN, Meta-data was used as a data descriptor. The sensor will use metadata to disperse information. Meta-data may avoid addressing the situation in such a manner as to lessen duplication of information at sensor nodes. It should be noticed that the size of the meta-data might not be as significant as that of the specific sensor data.

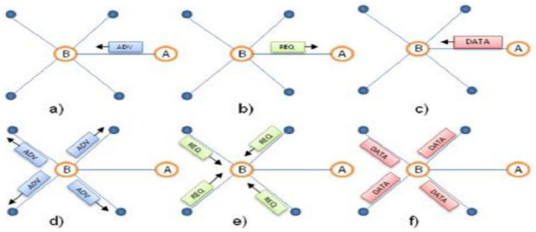

Fig 4: SPIN Protocol. Node A starts by advertising its data to node B (a). Node B responds by sending a request to node A (b). After receiving the requested data (c), node B then sends out advertisements to its neighbors (d), who in turn send requests back to B (e-f) [17].

In flooding, each sensor knows its asset utilization utilizing its own asset director that is looking at by the application previously any information preparing or transmission. This allows the sensors to track and respond to any adjustments implemented to their individual assets [17]. There are two frameworks in the SPIN group, such as SPIN-1and SPIN-2. Although SPIN-1 may perform the negotiating process, Optimized delivery of sensors, saving SPIN-2 Energy using the resource-conscious mechanism. However both frameworks allow sensors to share information about their sensor network. This helps them to view the data they're interested in. SPIN-1 requires a three handshake delivery mechanism. This framework relates to all systems that employ point-to-point propagation networks in which input signals interact without even a sensor node. There is a three-handshake procedure for SPIN-BC direct interaction SPIN-2 is distinct from SPIN-1 and differs from SPIN-1. The energy consumption of the sensor should be used. If any nodes have fewer assets than the threshold, the node cannot engage in the network. However, if the sensor has a limited residual value, Energy controls its participation in data propagation through the Oh-Method. Although, we are designing SPIN protocols for lossless networks. It can also be extended with minor adjustments to the lossy networks [18].

3.3 Directed Diffusion

The key highlights are named characteristic worth sets and way fortification. In this, the information is communicated by utilizing a naming plan for information. Direct dispersion utilizes the trait esteem sets for the information and on interest premise, questions the sensor utilizing those sets. The inquiry is made utilizing a rundown of characteristic worth matches, for example, name of articles, span, term, topographical territory, and so forth Figure 4 sums up the information dispersion conventions.

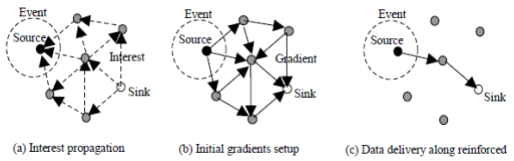

Fig 5: Directed diffusion protocol phases [3]

At the point when a hub known as the sink hub needs data about a specific quality, it communicates interest messages to the entirety of its neighbors. These interest messages are flooding through the organization and are added to every hub's advantage reserve. Each interest record in this reserve has at least one angle which compares to the neighboring hubs that sent the interest. The angle additionally stores the rate at which information is wanted, the span of the premium, and a timestamp. At the point when a hub produces information that coordinates an interest in its store, it sends the information back to the source along with the inclinations. Naturally, the information is attracted to the sink through the inclinations. The sink hub may fortify the briefest way i.e., the one with the quickest reaction, by sending a premium with a higher information rate along that way. Transitional hubs proliferate the support by looking at a nearby reserve of as of late sent information messages. The information store likewise forestalls circles in information conveyance. More slow information ways might be sent negative support, for example, interest messages with a moderate information rate to save network transmission capacity. In the event that a sink needs to keep accepting information, it must intermittently fortify the way to refresh the timestamp and span in the slopes [19] [20].

3.4 Energy-aware Routing (EAR)

Energy-aware routing, a variety of configured routes are used to prolong the lifetime of the system. With respect to the fact that the constant use of a route through which energy reduction is at the lowest possible level requires energy to be evacuated from the sensors available in that path, these routes are chosen by way of an alternative based on the energy ingesting of those routes. The continuous network is the most critical aspect to be addressed in the designing of this protocol. This protocol is the same as Directed Diffusion when it comes to seeking a route from the base query to the sensors. In directed diffusion, only the route is selected between certain routes that obtain the maximum input value level. Yet, in the EAR, the chosen way is picked by probability choice. The results of "synchronization" mean that EAR operates 21.5 percent well in the use of energy and 44 percent as "Directed Diffusion" in protracting network lifespan. In the other hand, EAR such as "Directed Diffusion" would not look at the dilemma for the

condition that does not work either direction selected, because it has multiple forms regardless of the primary way [21].

3.5 ACQUIRE

ACQURE (“Active Query Forwarding in Sensor Networks”) is another information-driven questioning system utilized for questioning named information. It gives the unrivalled question enhancement to answer explicit kinds of questions called one-shot complex questions for recreated information. The Acquire Inquiry (i.e., interest in the named information) comprises of a few sub-questions for which a few main sensors provide some basic reactions. Each sub-question to be highlighted relies on the data currently stored in its important sensor [22]. ACQUIRE enables a sensor to insert an active query following either a random trajectory or a specified trajectory into a network before some sensors on the path respond to the query using a localized update mechanism. In addition to ACQUIRE, other query methods enable the placement of a complicated query into the network to be redirected progressively via a series of sensors [11].

3.6 COUGAR

In a sensor networks, the undertaking can be assigned by the information base methodology in the cougar steering convention. This steering convention should include the potential for demonstrative inquiries found by the source sensors for an application and client programs. These inquiries are appropriate for WSNs so that, by recognizing the execution plan of their inquiries, they completely understand the customer. In other words, the customer is not aware about which sensors are struck, how the sensed information is prepared to work out the questions, and how the customer is transmitted with the final data. This direction-finding protocol uses a query layer in which the intermediate query between the organization layer and the sensor implementation layer is connected with each sensor. This investigation intermediary brings the upper-level offices concerns that may be posed from the access hub. Moreover, this methodology uses to diminish absolute energy utilization and improve network life expectancy. Cougar is valuable when an assortment of detected information and this information can be totalled in one informational index that is more significant and agent to the client. This convention is an information base methodology, it faces not many difficulties. The remote organization can look like a tremendous dispersed information base stem, where each sensor detected information in a subset of information. Henceforth, contemporary appropriated board approaches ought not to be applied straightforwardly, yet it's adjusted as needs are [23].

3.7 Rumor Routing

"Rumor Routing" is also a variety of "Directed Diffusion," that is essentially prepared for settings where its standards for regional communication are not appropriate. If there is no regional paradigm to diffuse activities, Total Guided Diffusion floods the investigation into the whole association. Nonetheless, it could be, frequently there is only a restricted measure of the data given by the hubs, thus the utilization of the flooding is superfluous. An elective philosophy is to attack the asset on the grounds that there are not many chances and an incredible number of issues. Tattle coordinating is between the flooding occasion and the flooding request [24]. The thought is to deliver the inquiries to the hubs who have experienced a specific occasion, instead of flooding the entire association, to recover information on the event of the occasions. In line with flooding occasions across the association, the tattle guiding estimation utilizes apparently unlimited parcels, called trained professionals. Experts dare to scatter information on adjoining occasions to distant hubs in any district of the association. At the point when a hub creates a sporadic question the hubs who realize the course will react to the inquiry by alluding to the occasion table. From this point forward, the measure of flooding has been detracted from the whole association. Tattle Routing guarantees a solitary way between the source and the objective instead of the Directed Diffusion, where data can be sent in an assortment of ways at low rates [11].

4. COMPARISION OF DATA-CENTRIC ROUTING PROTOCOL

Table 1: COMPARISION OF DATA-CENTRIC ROUTING PROTOCOL

Data-Centric Protocols	Mobility	Power Usage	Scalability	Data-aggregation	QOS	Advantages	Drawbacks
Flooding and gossiping	Limited	Limited	Limited	No	No	Increases reliability	Increases load on the network and processing Complexity
Spin	Possible	Limited	Limited	Yes	No	Overcomes classical flooding problem	Does not guarantee delivery of data
DD	Limited	Limited	Limited	Yes	No	• Eliminates repetition. • Minimizes the quantity of transmissions and accomplishes energy protection	• Is not suitable for applications which require QoS guarantee. • Enormous inertness as coordinating information to questions would require overhead.
EAR	Limited	Limited	N/A	Yes	No	• Achieves energy conservation. • Improves energy saving by 21.5%, and furthermore builds network life by 44% than DD.	• Limited memory storage for data caching. • Needs area data and setting up the tending to system for the hubs, which confounds course arrangement.
ACQUIRE	Limited	N/A	Limited	Yes	No	Able to deal with complex queries.	In the event that d is equivalent to arrange size, at that point the convention carries on like flooding.

COUGER	No	Limited	Limited	Yes	No	• Uses inquiries to digest inquiry handling. • Utilizes in-network information accumulation to get more energy reserve funds.	• Query may add additional overhead. • Synchronization among hubs is required.
RR	Very Limited	Limited	Good	Yes	No	• Achieves good energy savings than flooding-based one. • Handles node failures quite well.	• Unable to handle large number of events. • Not suitable for large networks.

4. Conclusion

A topical area of study, with a trivial but swiftly growing range of investigate findings, is routing in sensor networks. The big challenge for WSN is to design a routing protocol. The energy supplies for the sensors in WSN are insufficient, so energy conservation has become a key concern. In this article, we reviewed a comprehensive list of data-centric protocols and designing issues of routing protocols. There are certain issues which are addressed by researchers such as life time and energy consumption. In this paper, the analysis carried out on data routing in sensor networks was discovered and analyzed. The "data-centric" category was explicitly discussed and defined as well as the comparative analysis was done between these protocols on the basis of different matrices.

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